ORGANIC ELECTROLUMINESCENT DISPLAY AND MANUFACTURING METHOD THEREOF, ELECTRO-OPTIC DEVICE AND MANUFACTURING METHOD THEREOF, AND ELECTRONIC DEVICE

BACKGROUND OF THE INVENTION

1. FIELD OF THE INVENTION

The present invention relates to the construction of an organic electroluminescent (hereunder EL for short) display and a manufacturing method thereof, to an electro-optic device and a manufacturing method thereof, and to an electronic device. In particular the invention is one where, in a manufacturing method for a display incorporating microstructures made with drive circuits for organic EL elements, the organic EL display can be manufactured extremely efficiently.

2. DESCRIPTION OF RELATED ART

Heretofore, there is a method of manufacturing an electronic device using microstructures made with electronic circuit elements (refer for example to U.S. Patent Nos. 5904545, 5824186, 5783856, and 5545291).

That is, there is a manufacturing method which uses microstructures, and which enjoys for example the advantage that even with a configuration where a plurality of electronic circuits are scattered over a substrate of an electronic device, the semiconductor material need not be wasted.

Therefore, the present inventors and others, as a result of earnest research, as a means of utilizing microstructures in an organic EL display and a manufacturing method thereof, have completed a manufacturing method for obtaining an organic EL display

involving firstly, making a drive circuit for an organic EL element within a microstructure and arranging this on a transparent substrate, and then performing in sequence; a wiring forming step, a transparent electrode forming step, an emissive layer forming step and a cathode forming step. However while undoubtedly it has been shown that the organic EL display can be manufactured while enjoying the advantages from such a microstructure, in practice in order to mass produce the organic EL display with a profit base, further improvement is desired. Furthermore, this type of problem is also a common problem for electro-optic devices other than organic EL displays.

BRIEF SUMMARY OF THE INVENTION

The present invention has resulted due to such requirements, with the object of providing a method and an organic EL display construction whereby an organic EL display can be manufactured extremely efficiently, or a method and an electro-optic device construction whereby an electro-optic device can be manufactured extremely efficiently.

In order to achieve the above object, a first aspect of the present invention is a manufacturing method for a display which uses an organic EL element in a display portion, involving respectively preparing a circuit substrate with microstructures made with drive circuits for the organic EL element set at positions corresponding to pixels, and with wiring formed on the surface, and a transparent substrate with a transparent electrode layer common with the pixels laminated on the surface, and an emissive layer containing the organic EL layer and a cathode layer laminated on the upper surface of the transparent electrode layer at a position corresponding to the pixels, and then sticking together the circuit substrate and the transparent substrate with the side on which the wiring of the

circuit substrate is formed and the side on which the cathode layer of the transparent substrate is formed facing towards the inside.

A second aspect of the present invention is that in the manufacturing method for an organic EL display being the first aspect, the sticking together of the circuit substrate and the transparent substrate being performed by inserting an anisotropic conductive paste or an anisotropic conductive film therebetween.

The anisotropic conductive paste and anisotropic conductive film are already known products, being a paste and film which can be used as an adhesive. In the case where this is thinly interposed between the two members as an adhesive, this exhibits a low electrical resistance in the film thickness direction, and exhibits a high electrical resistance in the direction along the surface of the film.

A third aspect of the present invention is that in the manufacturing method for an organic EL display being the first aspect, this involves respectively preparing a roll of the circuit substrate, and a roll of the transparent substrate, and then unrolling the circuit substrate and the transparent substrate from these rolls while inserting an anisotropic conductive film therebetween, and pressing with a pressing roll from front and rear surfaces to thereby stick together the circuit substrate and the transparent substrate.

A fourth aspect of the present invention is that in the manufacturing method for an organic EL display being the third aspect, after sticking together the circuit substrate and the transparent substrate, the stuck together product being cut to an optional length.

In order to achieve the above object, a fifth aspect of the present invention is a display which uses an organic EL element in a display portion, microstructures made with drive circuits for the organic EL element being set at positions corresponding to pixels of a first substrate, and an emissive layer containing an organic EL layer being formed on at least one of the first substrate and a second substrate, and these first substrate and second

substrate being stuck together. That is, the emissive layer containing the organic EL layer may be formed on either one of the first substrate and the second substrate, or may be formed on both substrates, and the first substrate and the second substrate are stuck together so as to face each other through the emissive layer containing the organic EL layer.

Moreover, a sixth aspect of the present invention is a display which uses an organic EL element in a display portion, a circuit substrate with microstructures made with drive circuits for the organic EL element set at positions corresponding to pixels, and with wiring formed on the surface, and a transparent substrate with a transparent electrode layer common with the pixels laminated on the surface, and an emissive layer containing the organic EL layer and a cathode layer laminated on the upper surface of the transparent electrode layer at a position corresponding to the pixels, being stuck together with the side on which the wiring of the circuit substrate is formed and the side on which the cathode layer of the transparent substrate is formed facing towards the inside.

A seventh aspect of the present invention is that in the organic EL display being the sixth aspect, the circuit substrate and the transparent substrate being stuck together by inserting an anisotropic conductive paste or an anisotropic conductive film therebetween.

In order to achieve the above object, an eighth aspect of the present invention is a manufacturing method for an electro-optic device which uses electro-optic elements in a display portion, involving respectively preparing a first substrate with microstructures formed with drive circuits for the electro-optic elements set at positions corresponding to pixels, and a second substrate with the electro-optic elements formed at positions corresponding to the pixels, and then sticking together the first substrate and the second substrate with the side of the first substrate on which the drive circuits are formed and the side of the second substrate on which the electro-optic elements are formed facing towards

the inside. Here "electro-optic element" is an element such as for example the abovementioned organic EL element, or a liquid crystal element.

A ninth aspect of the present invention is an electro-optic device which uses electro-optic elements in a display portion, microstructures made with drive circuits for the electro-optic elements being set at positions corresponding to pixels of a first substrate, and an electro-optic layer being formed on at least one of the first substrate and a second substrate, and the first substrate and second substrate being stuck together. Here "electro-optic layer" may be a layer such as for example the abovementioned emissive layer containing the organic EL layer, or a film liquid crystal.

Furthermore, a ninth aspect of the present invention is characterized in that the electro-optic device of the abovementioned ninth aspect is provided.

According to the present invention, since an organic EL display is manufactured by sticking together a circuit substrate in which microstructures are set, and an emissive substrate formed with an emissive layer and the like, there is the effect that the organic EL display can be manufactured extremely efficiently.

In particular, according to the third and fourth aspects, since the organic EL display can be continuously manufactured, a reduction in manufacturing cost can also be achieved.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. 1 is a cross-sectional view showing the construction of a circuit substrate.

FIG. 2 is a cross-sectional view showing the construction of a transparent substrate.

FIG. 3 is a cross-sectional view showing the construction of an organic EL display.

FIG. 4 is a diagram illustrating a manufacturing process using rolls.

FIG. 5 is a perspective view illustrating a construction of a personal computer being an example of an electronic device of the present invention.

FIG. 6 is a perspective view illustrating a construction of a portable telephone being an example of an electronic device.

FIG. 7 is a perspective view illustrating a construction of a rear face side of a digital still camera being an example of an electronic device.

DETAILED DESCRIPTION OF THE INVENTION

Hereunder is a description of embodiments of the present invention based on the drawings.

FIG. 1 through FIG. 3 are diagrams illustrating a first embodiment of the present invention, FIG. 1 being cross-sectional view showing the construction of a circuit substrate 10 before being stuck, FIG. 2 being a cross-sectional view showing the construction of a transparent substrate 20 before being stuck, and FIG. 3 being a cross-sectional view showing the construction of an organic EL display 30 manufactured by sticking both members together.

That is, as shown in FIG. 1, on the surface of the circuit substrate 10 comprising an insulating material, there is formed a plurality of concavities 11 corresponding to the position of pixels of the organic EL display 30 which is made later, and inside these concavities 11 are inlayed microstructures 12. Then, the surface of the circuit substrate 10, in a condition with the microstructures inlayed therein, is covered by a protective film 13 made of an insulating material.

In the protective film 13 is formed through holes 13a for exposing electrode pads (not shown in the figure) formed on the surface of the microstructures 12, and wiring 14

such as scanning lines or signal lines is formed so as to conduct with the electrode pads through the through holes 13a.

As a manufacturing method for the microstructures 13, and a method of setting these in the concavities 11, the methods disclosed for example in U.S. Patent Nos. 5904545, 5824186, 5783856 and 5545291 may be applied. Furthermore, for the depositing method for the protective film 13, the method of opening the through holes 13a, and the patterning method for the wiring 14, known depositing methods and photolithography processes may be adopted.

On the other hand, as shown in FIG. 2, a transparent electrode layer 21 is deposited over the entire surface of the transparent substrate 20 made from a transparent synthetic resin or glass. Then, on the upper face of the transparent electrode layer 21 in the pixel forming regions which are mutually separated by banks 22 made of insulating material, is laminated from the transparent electrode layer 21 side, a hole injection layer 23, an organic EL layer 24 and a cathode layer 26, to thereby manufacture the emissive layer 25 with the hole injection layer 23 and the organic EL layer 24. For the materials for forming the transparent electrode layer 21, the hole injection layer 23, the organic EL layer 24 and the cathode layer 26, materials the same as known materials used in organic EL displays may be applied. Also, for the method of forming these, known manufacturing methods may be applied.

Then, the circuit substrate 10 shown in FIG. 1 and the transparent substrate 20 shown in FIG. 2 are stuck together as shown in FIG. 3 with the side formed with the wiring 14 and the side formed with the cathode layer 26 facing the inside, to thereby manufacture the organic EL display 30. Consequently, it is necessary to perform alignment of the circuit substrate 10 and the transparent substrate 20 and sticking together so that the portions of the wiring 14 to be connected to the cathode layer 26, and the

cathode layer 26 are electrically connected. Furthermore, in the sticking together of the circuit substrate 10 and the transparent substrate 20, since a known anisotropic conductive paste or an anisotropic conductive film is used, then unanticipated short circuits and the like can be avoided.

In this manner, according to the present embodiment, the circuit substrate 10 in which is set the microstructures 12, and the transparent substrate 20 formed with the emissive layer 25 and the cathode layer 26 are manufactured separately. In order to manufacture the organic EL display 30 with these two stuck together, then with regards to the circuit substrate 10, since the necessary processes are only a few after inlaying the microstructures 12 in the concavities 11, the possibility of the microstructures 12 made with electronic circuit elements such as transistors, capacitors and the like, being damaged by the manufacturing process can be greatly reduced.

Furthermore, since the circuit substrate 10 and the transparent substrate 20 are manufactured in separate processes, there is also the effect of an increase in yield. Depending on the situation, a manufacturing method is also possible where the circuit substrate 10 and the transparent substrate 20 are respectively manufactured at separate factories, or by different enterprises, and then finally the two are stuck together. Therefore this is also extremely effective in reducing manufacturing costs.

Furthermore, as also shown in FIG. 3, the light generated from the emissive layer 25 shines to the outside through the transparent electrode layer 21 and the transparent substrate 20. That is, the entire rear face side of the transparent substrate 20 becomes the screen of the organic EL display 30. However since wiring and the like which blocks light is not made on the transparent substrate 20, the aperture ratio of the organic EL display 30 can be made extremely high.

Moreover, the pitch of each pixel of the organic EL display 30 is determined by the pitch of the emissive layer 25 made on the transparent substrate 20, and the positioning accuracy at the time of sticking together the circuit substrate 10 and the transparent substrate 20 does not have any effect on the pitch of the pixels. Therefore, even if a manufacturing method involving sticking together as with the present embodiment is adopted, there is no drop in the accuracy of the pixel pitch of the organic EL display 30.

In this manner, according to the manufacturing method of the present embodiment, the organic EL display 30 can be extremely efficiently manufactured.

FIG. 4 is a diagram showing a second embodiment of the present invention, being a scheme for a sticking together process for the circuit substrate 10 shown in FIG. 1 and the transparent substrate 20 shown in FIG. 2.

That is, in this embodiment, on the surface of a long length circuit substrate 10 is formed the wiring 14 and the like as shown in FIG. 1, and a roll 100 is then prepared with the long length circuit substrate 10 rolled so that the wiring 14 side is on the outer surface side. Moreover, on the surface of a long length transparent substrate 20 of the same width as the circuit substrate 10 is formed an emissive layer 25 and the like as shown in FIG. 2, and a roll 200 is then prepared with the long length transparent substrate 20 rolled so that the cathode layer 26 side is on the outer surface side. Furthermore, a roll 400 made by rolling an anisotropic conductive film 40 of the same width as the circuit substrate 10 is also prepared.

Next, a pair of upper and lower pressing rollers 51 and 52 are positioned one in front of the other, the roll 100 and the roll 400 are arranged at the insertion side of the upstream pressing rollers 51, the roll 200 is arranged at the insertion side of the downstream pressing rollers 52, and a cutting device 53 is arranged further on the downstream side of the downstream pressing rollers 52.

Then, the long length circuit substrate 10 unwound from the roll 100 is inserted into the pressing rolls 51 with the wiring 14 side facing upwards, the anisotropic conductive film 40 unwound from the roll 400 is inserted into the same rollers 51 so as to lie on the upper face of the circuit substrate 10, and the two are made into one by the pressing force of the pressing rollers 51.

The circuit substrate 10 and the anisotropic conductive film 40 which have passed through the pressing rolls 51 are then continuously inserted into the pressing rollers 52, and the long length transparent substrate 20 which is unwound from the roll 200 is also inserted into the pressing rollers 52 in a condition with the cathode layer 26 facing downward and so as to lie on the circuit substrate 10 and while performing alignment of the two as described for the first embodiment. By so doing, due to the pressing force of the pressing rollers 52 and the adhesive strength of the anisotropic conductive film 40, the circuit substrate 10 and the transparent substrate 20 are stuck together in the condition as shown in FIG. 3.

Furthermore, the stuck together product of the circuit substrate 10 and transparent substrate 20 which has passed through the pressing rollers 52 is cut into predetermined lengths in the cutting device 53, to thereby give the organic EL display 30.

In this manner, according to the present embodiment, by using the previously prepared rolls 100, 200 and 400, the organic EL display 30 can be continuously manufactured. Therefore the manufacturing cost thereof can be further reduced.

In the above embodiment, the description has been given for an organic EL display as one example of an electro-optic device. However the present invention where microstructures formed with drive circuits are positioned in concavities on one substrate, and electro-optic elements are formed on an other substrate and these substrates are then stuck together, may, other than the organic EL substrate, be applied to electro-optic

devices of the self luminescent type such as plasma displays and electro-optic devices such as liquid crystal displays which use film liquid crystals.

Electronic devices

Next is a description of examples of electronic devices incorporating the abovementioned EL element drive circuits and EL display panels which are driven by these drive circuits.

First example: Mobile type computer

At first is a description of an example for where an organic EL display panel according to the embodiments is applied to a mobile type personal computer. FIG. 5 is a perspective view illustrating the construction of this personal computer. In the figure, a personal computer 1100 comprises a main frame 1104 incorporating a key board 1102, and a display unit 1106. The display unit 1106 has an organic EL display panel 100.

Second example: Portable telephone

Next is a description of an example for where an organic EL display panel is applied to a display portion of a mobile telephone. FIG. 6 is a perspective view illustrating the construction of this mobile telephone. In the figure, a mobile telephone 1200 incorporates a plurality of operating buttons 1202 as well as, an earpiece 1204, a mouth piece 1206 and the abovementioned organic EL display panel 100.

Third example: Digital still camera

Next is a description of a digital still camera which uses an organic EL display panel in a finder. FIG. 7 is perspective view illustrating the construction of this digital still camera, with connections for external equipment also shown simplified.

In contrast to a normal camera where the film is exposed by an optical image of a photographic subject, with the digital still camera 1300, the optical image of the photographic subject is photoelectrically converted by an imaging element such as a CCD (charged coupled device) to thereby produce an image signal. Here, the construction is such that the abovementioned organic EL display panel 100 is provided on a back face of a case 1302 of the digital still camera 1300, and display is performed based on the image signal from the CCD. Therefore the organic EL display panel 100 functions as a finder for displaying the photographic subject. Furthermore, on the viewing side (the rear face side in the figure) of the case 1302 there is provided a light receiving unit 1304 which includes an optical lens and a CCD or the like.

Here, when the photographer has confirmed the subject image displayed on the organic EL display panel 100 and pushes a shutter button 1306, the image signal from the CCD at that time is sent to a memory of a circuit substrate 1308 and stored therein. Furthermore, in this digital still camera 1300, on the side face of the case 1302 there is provided a video signal output terminal 1312 and an input-output terminal 1314 for data communication. Moreover, as shown in the figure, as required, a television monitor 1430 is connected to the former video signal output terminal 1312, or a personal computer 1430 is connected to the later data communication input-output terminal 1314. Furthermore, the construction is such that by a predetermined operation, the imaging signal stored in the memory of the circuit substrate 1308 is output to the television monitor 1430 or the personal computer 1440.

For the electronic device, in addition to the personal computer of FIG. 5, the mobile telephone of FIG. 6, or the digital still camera of FIG. 7, there can be given devices such as a liquid crystal television, a view finder type or direct view monitor type video recorder, a car navigation unit, a pager, an electronic notebook, an electronic calculator, a word processor, a work station, a video phone, a POS terminal, a device furnished with a touch panel and so on. Moreover, needless to say for the display portion of these various electronic devices, the abovementioned display device can be applied.